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Studies Relating to the Harvesting of Italian Prunes for Canning and Fresh Fruit Shipment

By

Henry Hartman

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THE ITALIAN PRUNE

The Italian prune originally came from Europe where it is known by the name of Fallenberg. It was introduced on the Pacific Coast in 1857, and since that time has been the basis of Oregon's prune industry. Of the 57,000 acres devoted to prune culture in this state, about 48,000 acres are planted to this variety. Probably not more than half of the plantings are now in full bearing. Though the major portion of the crop is marketed in the dried form, a considerable tonnage is canned or sold as fresh fruit. For the present at least, the acreage of Italian prunes should not be materially increased. The industry should confine its efforts rather to the improvement of its product and to the problems of distribution and marketing.

Studies Relating to the Harvesting of Italian Prunes for Canning and Fresh Fruit Shipment

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INTRODUCTION

That there is need for more information relating to the harvesting, canning, and shipping of Italian prunes has been evident for some time. The present methods of handling these prunes have not proved entirely satisfactory, and growers and shippers feel that additional experimental work should be done in this field.

Scope of report. The present study, which is a part of the general fruit handling project of the Oregon Experiment Station, was undertaken in 1924. The investigations during the first season, however, were somewhat elementary in character and the more important phases of the work were not undertaken until 1925. This circular, therefore, is largely of the nature of a progress report. No attempt has been made to review completely the literature appertaining to the handling of prunes, and additional work must be done before final conclusions can be drawn.

Fruit from various sources used. To make the work as representative as possible, the fruit used in these experiments was taken from several orchards in the Willamette and Walla Walla valleys, the chief Italian prune districts of Oregon. The fruit from the Willamette Valley came from the Oaco orchard at Monroe, and from the College orchard at Corvallis, the former situated on red hill soil and the latter on the more or less heavy flat land of the Valley floor. Both orchards are non-irrigated. The fruit from the Walla Walla Valley was taken from the Roeder, Love, and Hopson orchards near Milton-Freewater. These orchards represent fairly well the various conditions under which prunes are grown in the district. The Roeder orchard is situated on the so-called "rocks" at a fairly low elevation. The Love orchard is situated on heavier soil, also at a fairly low elevation. The Hopson orchard is situated on rather heavy soil at a comparatively high altitude. All three orchards are under irrigation.

EXPERIMENTAL

TIME OF PICKING IN RELATION TO FRESH FRUIT QUALITY

Plan of experiments. Casual observation as well as experimental evidence have emphasized the fact that the degree of maturity which the fruit has attained at picking time exerts a pronounced influence upon its dessert and keeping qualities. With the hope of gaining more infor-

mation on this factor as it applies to the Italian prune, a rather comprehensive time-of-picking test was conducted during the season of 1925.

Beginning on July 31 and ending August 19, seven separate pickings were made at intervals of three days from the Roeder and the Love orchards at Milton-Freewater. During this range of picking season, the fruit on the trees passed from a stage of comparative immaturity to one somewhat beyond the optimum picking time for fresh fruit shipment. None of the fruit, however, became tree ripe during this period.

Shortly after picking, the fruit was placed in storage at 45° Fahrenheit, a temperature comparable, in the main, to that of the refrigerator cars in which fresh prunes are shipped. In each case, the fruit was held at this temperature for 12 days, the average length of time that it takes for a car to reach the eastern markets, and at the end of the 12 days it was removed to a temperature of 66° F. and allowed to ripen. Observations were made with the aim of determining, so far as possible, the effects of time of picking on (1) the dessert quality, (2) keeping quality, (3) size, (4) sugar content, (5) acid content, and (6) solid content.

In addition, ten separate pickings were made from the Oaco orchard at Monroe the first on August 10, and the final one on September 12. At the time of the first picking, the prunes were somewhat green, but toward the end of the season they were fully matured, the final lot consisting largely of fruits gathered from the ground. All lots too green for eating out of hand at the time of picking were allowed to ripen at a temperature of 66° F. Observations were made as in the case of the fruit from Milton-Freewater.

Tables I to VII inclusive give the data obtained in the time-of-picking tests.

TABLE I. EFFECTS OF TIME OF PICKING ON THE FRESH FRUIT QUALITY OF ITALIAN PRUNES

Oaco Orchard (Monroe)

Lot. No.	Date of picking	Pressure test	Sugar in raw juice (Balling)	Acid in raw juice (malic)	Average weight of specimens	Increase in weight	Condition at time of picking.
		lbs.	%	%	*gr.*	%	
1	8/10	17.4	12.6	1.74	29.6	------	Very firm. Flesh greenish in color. About half of surface covered with blue. Very sour and inedible as fresh fruit.
2	8/13	15.6	14.6	1.87	30.6	3.3	Very firm. Flesh greenish in color. A little better colored. Slightly less sour but inedible as fresh fruit.
3	8/16	12.3	15.1	1.60	33.5	13.1	Less firm. Flesh juicier and more yellowish in color. Prevailing effect, blue. Inedible as fresh fruit.
4	8/19	10.3	15.2	1.23	35.0	18.2	Fruit spongy and softer in texture. Flesh fairly juicy, stringy and yellowish in color. Much better in quality but too green for eating fresh.
5	8/22	8.1	16.8	1.20	36.2	22.3	Fruit spongy and softer in texture. Flesh fairly juicy, stringy and yellowish in color. Good blue color. Still too green for eating fresh.
6	8/26	6.5	16.3	1.21	36.3	22.6	Fairly soft in texture. Flesh juicy, stringy, golden yellow in color. Deep blue color. A few specimens about ripe enough to eat.
7	8/31	5.5	18.9	1.18	36.9	24.6	Fairly soft in texture. Flesh juicy, stringy, golden yellow in color. Most specimens about ripe enough for eating. Full blue color.
8	9/4	5.2	18.8	.830	37.7	27.4	Soft in texture. Flesh very juicy, stringy, golden yellow in color. Most specimens ripe enough to eat. Full blue color.
9	9/8	4.8	18.3	.830	37.5	26.7	Soft in texture. Flesh very juicy, stringy, golden yellow in color. All ripe enough for eating. Full blue color.
10	9/12	3.8	18.5	.822	36.1	21.9	Very soft in texture. Flesh very juicy, stringy, golden yellow in color. Past prime condition. Deep blue color.

TABLE II. EFFECTS OF TIME OF PICKING AND STORAGE ON THE FRESH FRUIT QUALITY OF ITALIAN PRUNES

Love Orchard (Milton-Freewater) Stored at 45° F. Ripened at 66° F.

Lot No.	Date of picking	Pressure test at time of picking	Condition at time of picking	Date of storing at 45° F.	Condition at time of removal from 45° F.	Date of storing at 66° F.	Date of full maturity	Number of days to reach full maturity	Condition at full maturity
		lbs.							
1	7/31	16.0	Very firm. Flesh greenish in color. Prevailing effect, blue. Very sour and inedible as fresh fruit.	8/1	immature	8/13	8/20	20	Flesh somewhat tough, greenish in color. Rather tart. Fair in quality. Deep purple color. Slightly wilted. Held up well.
2	8/3	15.7	Very firm. Flesh greenish in color. Prevailing effect, blue. A little less sour, but inedible as fresh fruit.	8/4	immature	8/16	8/22	18	Flesh somewhat tough, greenish in color. Less tart, spicy, fairly good in quality. Deep purple color. Held up well.
3	8/6	14.1	Firm. Flesh greenish-yellow, juicier. Prevailing effect, blue. A little less sour but inedible as fresh fruit.	8/7	immature	8/19	8/23	16	Flesh breaking, stringy, greenish-yellow in color. Less tart, spicy, good in quality. Deep purple color. Held up well.
4	8/9	12.8	Fairly firm. A few specimens soft. Flesh greenish-yellow, stringy. Good blue color. Better in quality, but inedible as fresh fruit.	8/10	immature	8/22	8/25	16	Flesh breaking, stringy, yellowish in color. Spicy, good in quality. Deep purple color. Held up fairly well.
5	8/12	12.7	Fairly firm. Some specimens soft. Flesh greenish-yellow, stringy and fairly juicy. Deep blue color. Better quality but inedible as fresh fruit.	8/13	slightly immature	8/25	8/27	14	Flesh breaking, stringy, yellowish in color. A little milder than previous lots. Did not keep flavor long. Deep purple color. Went down quickly.
6	8/15	11.6	Less firm. Some specimens quite soft. Flesh yellowish, stringy, and fairly juicy. Deep blue color. Still inedible as fresh fruit.	8/16	ripe	8/28	8/28	12	Flesh breaking, stringy, yellowish in color. Mild in taste, soon becoming flat. Deep purple color. Went down quickly.
7	8/18	8.3	Much softer. Some specimens tree ripe. Flesh golden yellow, stringy, and juicy. Generally too green for eating as fresh fruit.	8/19	overripe	.....	8/25	5	Flesh breaking, stringy, golden yellow. Mild soon becoming flat. Deep purple color. Went down rapidly.

TABLE III. EFFECTS OF TIME OF PICKING AND STORAGE ON THE FRESH FRUIT QUALITY OF ITALIAN PRUNES

Roeder Orchard (Milton-Freewater) Stored at 45° F. and 66° F.

Lot No.	Date of picking	Pressure test at time of picking	Condition at time of picking	Date of storage at 45° F.	Condition at time of removal from 45° F.	Date of storing at 66° F.	Date of full maturity	Number of days to reach full maturity	Condition at full maturity
		lbs.							
1	7/31	14.1	Firm. Flesh greenish-yellow. Prevailing effect, blue. Rather tart and inedible as fresh fruit.	8/1	immature	8/13	8/18	18	Flesh breaking, greenish-yellow in color, juicy and stringy in texture. Spicy and good in quality. Not shrivelled. Deep purple color. Held up well.
2	8/3	13.9	Firm. Flesh greenish-yellow. Fairly juicy and somewhat stringy in texture. Prevailing effect, blue. Tart and inedible as fresh fruit.	8/4	immature	8/16	8/20	17	Flesh breaking, greenish-yellow in color. Juicy, stringy in texture. Good in quality. Deep purple color. Held up well.
3	8/6	12.7	Fairly firm. Flesh greenish-yellow, juicy and stringy in texture. Prevailing effect, blue. Riper, but inedible as fresh fruit.	8/7	immature	8/19	8/20	14	Flesh breaking, greenish-yellow in color. Juicy, stringy in texture. Good in quality. Deep purple color. Held up fairly well.
4	8/9	11.1	Less firm, a few specimens becoming soft. Flesh yellowish, juicy and stringy in texture. Good blue color. Not edible as fresh fruit.	8/10	mature	8/22	8/22	13	Flesh breaking, yellowish in color, juicy and stringy in texture. Mild in taste, becoming flat. Deep purple color. Went down rather quickly.
5	8/12	10.7	Becoming softer, a few specimens about ready to eat. Flesh golden yellow, juicy and stringy. Deep purple color. Generally not edible as fresh fruit.	8/13	slightly over-mature	8/25	8/23	11	Flesh breaking, yellowish in color, juicy and stringy in texture. Mild in taste, becoming flat. Deep purple color. Went down rather quickly.
6	8/15	9.4	Becoming softer, a few specimens ready to eat. Flesh golden yellow, juicy and stringy. Deep blue color. Generally inedible as fresh fruit.	8/16	over-mature	.....	8/23	8	Flesh breaking, yellow in color, juicy and stringy in texture. Mild in taste, soon becoming flat. Deep purple color. Went down rather quickly.

TABLE IV. EFFECTS OF TIME OF PICKING AND STORAGE ON THE FRESH FRUIT QUALITY OF ITALIAN PRUNES

Oaco Orchard (Monroe) Stored and Ripened at 66° F.

Lot No.	Date of picking and storing	Pressure test at time of picking	Condition at time of picking	Date of full maturity	Number of days to reach full maturity	Condition at full maturity
		lbs.				
1	8/10	17.4	Very firm. Flesh greenish in color. About half of surface covered with blue. Very sour and inedible as fresh fruit.	9/3	24	Flesh somewhat tough and rubbery, greenish in color. Somewhat tart. Fair in quality. Deep purple color. Held up well.
2	8/13	15.6	Very firm. Flesh greenish in color. A little better colored. Slightly less sour but inedible as fresh fruit.	9/1	19	Flesh somewhat tough but less rubbery, greenish in color. Less tart. Fairly good in quality. Deep purple color. Held up well. Ideal for shipping.
3	8/16	12.3	Less firm. Flesh juicier and more yellowish in color. Prevailing effect blue. Inedible as fresh fruit.	8/31	15	Flesh breaking, greenish yellow in color, juicier and more stringy in texture. Good in quality. Deep purple color. Held up well. Ideal for shipping.
4	8/19	10.3	Fruit spongy and softer in texture. Flesh fairly juicy. Stringy and yellowish in color. Much better in quality but too green for eating fresh.	8/31	12	Flesh breaking, yellowish in color, juicy and stringy. Milder in taste, soon becoming flat. Deep purple color. Went down quickly.
5	8/22	8.1	Fruit spongy and softer in texture. Flesh fairly juicy, stringy and yellowish in color. Good blue color. Still too green for eating fresh.	8/29	7	Flesh breaking, deep yellow in color, juicy and stringy. Mild in taste, soon becoming flat. Deep purple color. Went down quickly.
6	8/26	6.5	Quite soft in texture. Flesh juicy, stringy, golden yellow in color. Deep blue color. A few specimens ripe enough to eat.	8/29	3	Flesh breaking, deep yellow in color, juicy and stringy. Mild in taste, soon becoming flat. Deep purple color. Went down quickly.

TABLE V. EFFECTS OF TIME OF PICKING ON THE WEIGHT AND VOLUME OF ITALIAN PRUNES

Oaco Orchard (Monroe)

Lot	Date of picking	Sugar in raw juice (Balling)	Specific gravity of raw juice	Average weight of specimens	Increase in weight	Average volume of specimens	Increase in volume
		%		*gr.*	%	*c. c.*	%
1	8/10	12.6	1.0510	29.6	------	28.1	--------
2	8/13	14.6	1.0596	30.6	3.3	28.8	2.5
3	8/16	15.1	1.0617	33.5	13.1	31.5	12.1
4	8/19	15.2	1.0621	35.0	18.2	32.9	17.0
5	8/22	16.8	1.0691	36.2	22.3	33.8	20.3
6	8/26	16.3	1.0669	36.3	22.6	34.0	21.0
7	8/31	18.9	1.0783	36.9	24.6	34.2	21.7
8	9/4	18.8	1.0779	37.7	27.4	35.0	24.5
9	9/8	18.3	1.0757	37.5	26.7	34.9	24.2
10	9/12	18.5	1.0766	36.1	21.9	33.5	19.2

TABLE VI. EFFECTS OF TIME OF PICKING AND STORAGE ON THE SUGAR AND ACID CONTENT OF ITALIAN PRUNES

Love Orchard (Milton-Freewater) Stored 12 days at 45° F. ripened at 66° F.

Lot No.	Date of picking	Date of storing at 45° F.	Date of storing at 66° F.	Date of full maturity	Number of days to reach full maturity	Pressure test at time of picking	Sugar in raw juice at time of picking (Balling)	Sugar in raw juice at full maturity (Balling)	Acid in raw juice at time of picking (malic)	Acid in raw juice at full maturity (malic)
						lbs.	%	%	%	%
1	7/31	8/1	8/13	8/20	20	16.0	13.9	14.0	1.44	.96
2	8/3	8/4	8/16	8/22	18	15.7	14.5	13.1	1.42	.80
3	8/6	8/7	8/19	8/23	16	14.1	14.6	13.5	1.58	.93
4	8/9	8/10	8/22	8/25	16	12.8	13.8	15.5	1.43	.70
5	8/12	8/13	8/25	8/27	14	12.8	14.5	16.1	1.40	.67
6	8/15	8/16	8/28	8/28	12	11.6	15.2	15.6	1.47	.72
7	8/18	8/19	8/30	8/25	5	8.3	18.1	16.2	1.07	.66

TABLE VII. THE EFFECTS OF TIME OF PICKING AND STORAGE ON THE TOTAL SOLIDS OF ITALIAN PRUNES

Oaco Orchard (Monroe) Stored at 66° F.

Lot No.	Date of picking and storing	Pressure test at time of picking	Date of full maturity	Number of days to reach full maturity	Total solids at time of picking	Total solids at full maturity
		lbs.			%	%
1	8/10	17.4	9/3	24	13.4	12.5
2	8/13	15.6	9/1	19	13.3	12.8
3	8/16	12.3	8/31	15	14.4	14.6
4	8/19	10.3	8/31	12	15.0	15.4
5	8/22	8.1	8/29	7	15.3	15.3

DISCUSSION OF RESULTS ON TIME OF PICKING

Time of picking affects the dessert quality. That time of picking affects the ultimate dessert quality of Italian prunes was clearly shown by the results of these experiments. When picked prematurely, the fruit never attained the quality characteristic of the variety. It remained tough in texture, sour in taste, and was inclined to shrivel in storage. When picked too late, on the other hand, the prunes soon lost their spiciness and became flat in taste.

Time of picking affects the storage life. Time of picking also affected, in a marked degree, the keeping quality or storage life of the fruit. This is shown by the data given in tables II, III, and IV and Fig. 1. These show that the prunes from the Oaco orchard, harvested on August 10, required 24 days to reach full maturity at 66° F., while those from the same orchard harvested on August 26 required only 3 days to become fully ripe at this temperature. Fruit picked on July 31 from the Love orchard and held at 45° and 66° F. required 20 days to ripen, while that picked on August 19 was ripe in five days from the time of picking.

In all cases, the lots picked beyond the optimum picking time broke down rapidly after reaching full maturity. Fruit picked early or at

mid-season, on the other hand, held up for a considerable length of time after ripening.

Obviously, if storage life was the only item to consider, early picking would be a desirable practice, but it is clear that if dessert quality and other factors are to be taken into account, keeping quality must be sacrificed to a certain extent. It appears from these data, however, that if picking is done at the proper time the fruit will develop fairly good dessert quality and will still retain sufficient shipping quality to reach the eastern markets in good condition with ample time for distribution and consumption. In fact, there is but little doubt that the reputation of the fresh Italian prune has suffered in the past, not because it was picked too green, but because it was sold to the consumer too soon. What was potentially a first class product was sacrificed because the trade and consuming public did not give it sufficient time to develop its best quality. That there is need for education on this point is apparent.

LOT NO.	DATE OF PICKING AND STORING	PRESSURE TEST	DATE OF FULL MATURITY	NUMBER OF DAYS TO REACH FULL MATURITY AT 66° F.
1	8/10	17.4	9/3	24
2	8/13	15.6	9/1	19
3	8/16	12.3	8/31	15
4	8/19	10.3	8/31	12
5	8/22	8.1	8/29	7
6	8/26	6.5	8/29	3

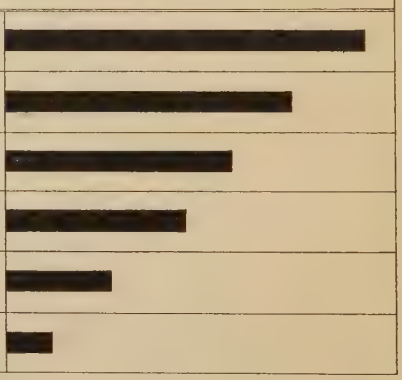

Fig. 1. The effects of time of picking on the storage life of Italian prunes.

Increase in weight and volume. A matter of particular interest to growers of prunes is that of increase in weight and volume during the ripening period. What sacrifice in tonnage does the grower make when he picks his prunes early in the season for fresh fruit shipment? And conversely, what increase may he expect if he allows them to ripen on the trees for canning or drying purposes?

The figures presented in Table V and Fig. 2 show that Italian prunes may undergo a rather significant increase in weight and volume during the harvesting season. From the beginning of the fresh fruit shipping period to the time when the fruit was fully ripe on the trees, the prunes in the Oaco orchard showed an increase in weight of 24.1 percent and an increase in volume of 22.0 percent. These data show also that while the greatest increase in weight and volume took place early in the picking season, the specimens continued to gain until they were tree ripe. Following this time they showed a slight decrease in both weight and volume. This can be accounted for by the fact that the fruit began drying on the trees as soon as full maturity was reached.

Acid content decreases. That the acidity of Italian prunes undergoes change during the ripening period was evident from the results of these tests. Tables I and VI, for example, show that the acid content of these prunes underwent a gradual and consistent reduction, not only while the fruit was attached to the tree, but also while it was in storage. From the time of the first picking to that of the last, the acid content of the fruit on trees in the Oaco orchard was reduced from 1.74 to 0.82 percent, while that of the fruit in the Love orchard was reduced from 1.44 to 1.07 percent. Fruit from the Love orchard held in storage showed a

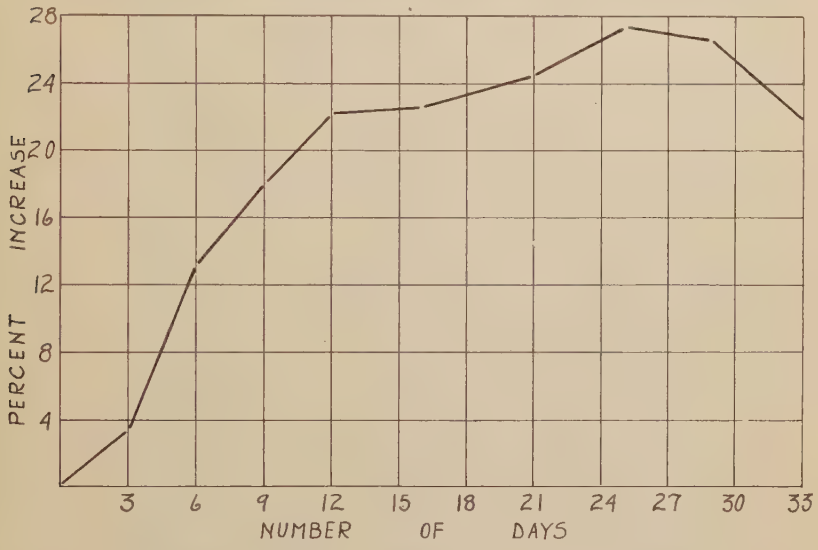

Fig. 2. Graph showing the increase in weight of Italian prunes during the ripening period.

reduction in acid from 1.44 to 0.96 percent between July 31 and August 20. All other lots held in storage showed corresponding losses of acidity.

The acid content in all cases was determined by titrating the fresh juice with N/10 sodium hydroxide, the acid present being calculated as malic. While it is recognized that other means of measuring acidity might give truer values, no other method proved feasible under the conditions of these experiments.

Acid content influences quality. There is apparently a close correlation between acidity and the dessert quality of Italian prunes. When ripened in storage, the prunes were generally at their best when the acid content was between 1.0 and 0.5 percent. In case the acid content was more than 1.0 percent the fruit was sour and usually inedible. When it was below 0.5 percent, the prunes were usually insipid and lacked in character. Generally the riper the fruit at the time of picking, the sooner it lost its acidity in storage. A reddish condition of the flesh usually indicates low acidity in storage prunes.

Sugar content increases. That Italian prunes show an increase in sugars during the ripening period is shown by the data given in tables I and VI. From these it will be seen that the juice of the prunes from the Oaco orchard showed an increase in sugar and other soluble solids from 12.6 to 18.9 percent between August 10 and August 31. Prunes held in storage, on the other hand, showed no increase, but rather a slight decrease in sugar and other soluble solids during the storage period. This is in keeping with the observations regarding quality. Obviously, the major changes in quality after picking are due to the loss of acidity and astringency, rather than to increases in the amounts of sugar.

The percentages of sugar indicated in tables I and VI were determined by means of a Balling scale hydrometer applied to the raw juice. The figures given, therefore, cannot be taken as indicating the exact amounts of sugar present. Rather they express the percentages of soluble solids. For a comparative study of sugar changes, however, they are fairly adequate, as indicated by the results of analyses for total sugars.

Increase in solid content. The fact that time of picking affects somewhat the solid content of fruits has been common knowledge for some time. Table VII throws some light on this factor as it applies to prunes. According to these figures, the solid content of prunes on the trees in the Oaco orchard increased from 13.3 to 15.3 percent from August 10 to August 22. Fruit held in storage apparently underwent no material change in solid content.

To determine the solid content, a certain amount of fresh pulp was dried down in the Freas Electric Vacuum oven, weighings being made before and after drying. The figures given, therefore, indicate the percents of total solids.

DETERMINATION OF MATURITY

When left to their own discretion, growers have generally determined the time of picking in Italian prunes by the aid of such factors as color, texture of the flesh, adhesion of the flesh to the pit, and size of the fruit. It is generally admitted, however, that these are not entirely satisfactory guides of maturity. Obviously they are capable of various interpretations, with the result that controversies arise and that Italian prunes are harvested at widely varying stages of ripeness. Doubtless there is need for a test that will indicate rather definitely the degree of maturity, that will exclude the human element, so far as possible, and that can be easily and quickly applied.

Sugar test fails. The so-called sugar test which has proved fairly satisfactory in determining the maturity of oranges, grapes, and cherries, does not seem to be applicable to the Italian prune. While these prunes show a gradual increase in sugar and other soluble solids during the ripening period, the most significant increase occurs late in the season, and the average daily changes just before and during the time of fresh fruit shipment are not sufficiently indicative to make the test reliable. The fruit from the Love orchard, for example, showed an average daily increase in sugar and other soluble solids of only .08 percent during this time. The probability of error in applying the test becomes very great when such minor differences must form the basis of calculations.

Acid test proves ineffective. The reason given for the failure of the sugar test apparently applies with equal force to the acid test. While a considerable decrease in acidity occurs during the season as a whole, the reduction that takes place from time to time is probably too small to be of value in determining time of picking.

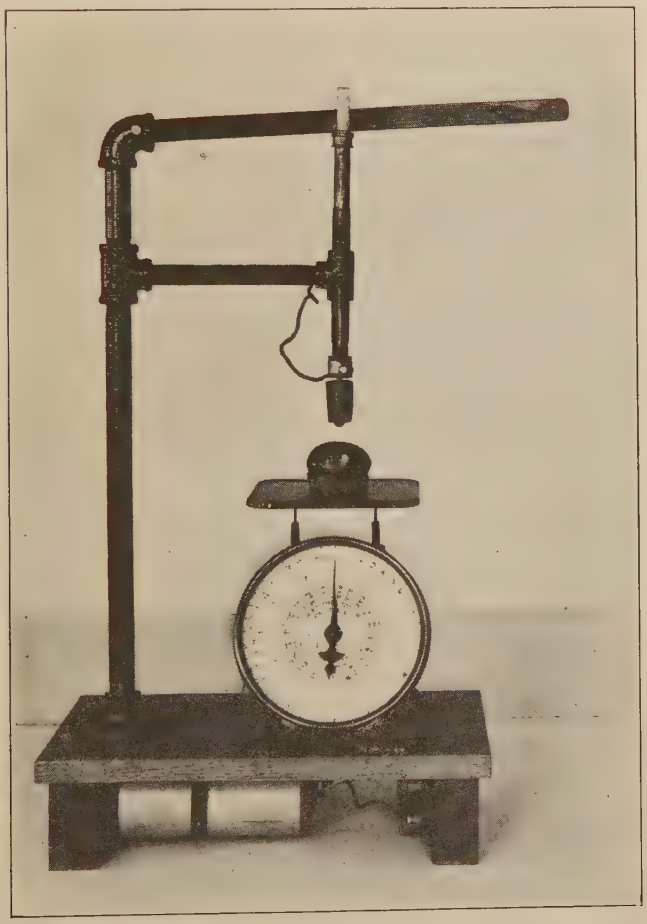

Fig. 3. Special type of the Oregon pressure tester used on Italian prunes. The pressure tester was first perfected by the Oregon and the Washington Experiment Stations.

The pressure test. The pressure test is the only guide of maturity which seems to be applicable to the Italian prune at this time. This test is based upon the fact that during the growth and ripening of the fruit there is a gradual and consistent lowering of the physical resistance to pressure or wounding of the epidermal and cortical region. In the case of Bartlett pears, for example, the decrease in resistance is about two percent every twenty-four hours.[1] To measure the changes in re-

sistance a simple apparatus now known as the "iron thumb" or "pressure tester" has been perfected. A complete description of the pressure tester and its application is given in Oregon Experiment Station bulletins 186 and 206.[2] The instrument constructed for the work on prunes (Fig. 3) has a rounded plunger, $\frac{3}{8}$ of an inch in diameter and records the resistance in pounds.

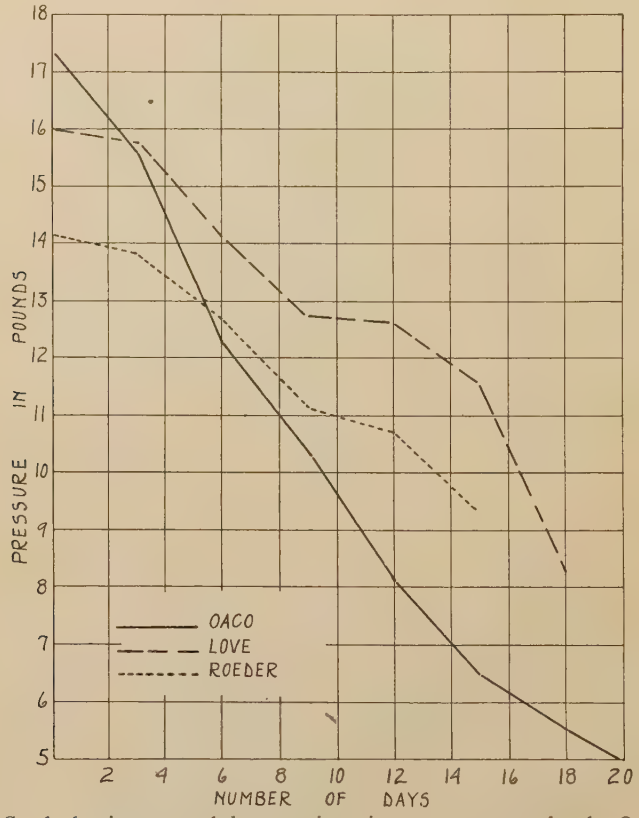

Fig. 4. Graph showing seasonal decreases in resistance to pressure for the Oaco, Love, and Roeder orchards in 1925.

Prunes show decrease in resistance. That Italian prunes show a consistent and pronounced decrease in resistance to pressure during the ripening period is apparent from the data given in tables I, II, III, and IV, and Fig. 4. The fruit from the Oaco orchard in 1925, for example, showed a reduction of 13.6 pounds between August 10 and September 12, that from the Love orchard showed a reduction of 7.7 pounds between July 31 and August 19, while that from the College orchard in 1924 showed a reduction of 7.5 pounds between August 12 and August 30. This gives an average daily decrease of .41 pound for the Oaco and College orchards and .42 pound for the Love orchard. Figures for other orchards during the past two years show similar decreases in resistance during the season.

Practical application. From the records of these experiments, it appears that Italian prunes for fresh fruit shipment should be harvested when the pressure tester registers between 15 and 12 pounds. The fruit picked when within this range of pressure has generally developed fairly good quality and has held up sufficiently well to permit transportation and distribution. The fruit picked when the tester registered above 15 pounds usually held up well but did not develop satisfactory quality. That picked when the test was below 12 pounds was inclined to ripen up quickly and lost its flavor in a comparatively short time. Additional work must be done, however, before final recommendations can be made concerning picking pressures.

Only normal, average specimens should be used in making the test; specimens that are blemished, wormy, overcolored, or wilted should be eliminated. To obtain a fair average, from 20 to 30 fruits are necessary. The best results are usually obtained when the fruit for testing is harvested early in the morning, and when the test is made immediately after picking.

Fig. 5. Pressure punctures on Italian prunes.

Caution must be used. Although striking results have been obtained here and elsewhere, it is clear that the pressure tester can be of value only when applied with care and intelligence. The instrument is by no means "fool proof" and can be reliable only when used by some one who is willing to make a study of the factors involved. Promiscuous application of the tester can but lead to erroneous conclusions.

Time of picking varies with different orchards. As can be seen from the figures presented, the fruit in the various Italian prune orchards did not reach the proper picking stage at the same time. On August 31, for example, the fruit from the Roeder orchard tested 14.1 pounds; that from the Love orchard, 16.0 pounds; and that from the Hopson orchard, 17.5 pounds. Judging from the pressure reading and from subsequent storage and maturity tests, the Roeder orchard was generally from 5 to 6 days earlier than the Love orchard, which in turn was from 3 to 4 days earlier than the Hopson orchard. The fruit from the College orchard was about one week earlier than that from the Oaco orchard. In general, the trees in the lower situations were more advanced than those at the higher altitude.

TABLE VIII. THE RELATION OF THE PRESSURE TEST TO MATURITY IN ITALIAN PRUNES
(Milton-Freewater)

Lot No.	Date of picking	Pressure test		*U. S. Inspector's Rating as to Maturity	
		Roeder orchard	Love orchard	Roeder orchard	Love orchard
		lbs.	*lbs.*		
1	7/31	14.1	16.0	Generally mature hard. Occasional specimen immature.	Generally immature. Occasional specimen mature hard.
2	8/3	13.9	15.7	Generally mature hard. Occasional specimen immature.	Generally immature. Occasional specimen mature hard.
3	8/6	12.7	14.1	Generally mature. Occasional specimen mature hard.	Generally mature hard. Occasional specimen mature.
4	8/9	11.1	12.8	Generally mature. Occasional specimen mature hard.	Generally mature hard. Occasional specimen mature.
5	8/12	10.7	12.7	Generally mature. Occasional specimen mature ripe.	Generally mature. Occasional specimen mature hard.
6	8/15	9.4	11.6	Generally mature. Occasional specimen mature ripe.	Generally mature. Occasional specimen mature hard.
7	8/18	.....	8.3	.....	Generally mature. Occasional specimen mature ripe.

*Inspection by R. F. Wilbur, Milton-Freewater, Oregon.

DISEASES OF PRUNES IN STORAGE

Fungous diseases are the chief cause of decay in Italian prunes after harvest. These, in general, can be divided into two groups; (1) those that have the ability to penetrate the sound fruit, (2) those that follow in the wake of other diseases or gain entrance through mechanical injuries. An example of the former is brown rot (Sclerotinia cinerea),[3] which in some years is serious in all stone fruits grown west of the Cascade Mountains. This trouble must be controlled by spraying and by the application of sanitary measures in the orchard. The latter class of diseases is represented by the common gray mold (Botrytis) and blue mold (Penicillium).[4] These are responsible for decay in Italian prunes from all sections. The present experiments have shown that mold is especially prevalent on prunes that have been picked with torn stems and that have been bruised in handling operations.

COLOR DEVELOPMENT AFTER HARVEST

Unlike many other fruits the Italian prune takes on color after harvest. In the present experiments, prunes that were almost devoid of color at picking time developed full color during the storage period. This was true both of the fruit held in common and of that in cold storage. If this is generally true, color at picking time need not be a hard and fast requirement.

TIME OF PICKING IN RELATION TO CANNING QUALITY

In past years the canning industry has centered its attention primarily upon processing methods and has given only slight consideration to the handling of the raw product. It is now generally admitted, however, that the vicissitudes of canning are due not alone to variations in the canning procedure, but also to the treatment the product receives in the orchard or field, on the way to the cannery or in storage.

Plan of experiment. To gain information on time of picking as it related to the canning quality of Italian prunes, the following experiment was carried on during the season of 1925: Beginning on August 10 and ending on September 12, pickings of Italian prunes were made at intervals of three and four days from the Oaco orchard. Altogether ten separate pickings were made. Within this range of season, the fruit passed from a stage of comparative immaturity to one somewhat beyond the optimum picking time.

Part of the fruit from each picking was immediately canned in accordance with the best known commercial canning practices. The fruit in each case was processed in 40 percent sirup. Each lot was cooked for 18 minutes by the open kettle method and was given an exhaust of 15 minutes in water at a temperature of 175° F. Common No. 2½ enamel-lined tins were used. In the case of the lots picked early in the season, a part of the fruit from each picking was placed in storage and allowed to ripen at a temperature of 66° F. When fully ripe this fruit was canned as before. Observations of the canned product were made about five months after canning, with the aim of ascertaining the effects of time of picking on (1) quality, (2) appearance, (3) sirup cut-out, (4) fruit cut-out, (5) shrinkage, and (6) acid content. The data obtained in this experiment are given in tables IX, X, and XI.

TABLE IX. EFFECTS OF TIME OF PICKING ON THE CANNING QUALITY OF ITALIAN PRUNES

Oaco Orchard (Monroe) Canned in 40 percent sirup.

Lot No.	Date of picking and canning	Sirup cut-out (Balling)	Acid in sirup (malic)	Loss of weight (fruit)	Loss of volume (fruit)	Quality of canned product
		%	%	%	%	
1	8/10	26.0	.99	6.7	12.9	Fruit light green in color, no indication of red. Flesh fair in texture. Fair in quality. Fairly tart. Juice clear, no indication of color.
2	8/13	26.5	.89	6.3	12.4	Fruit light green in color, faint trace of pink. Flesh a little better in texture. Fair in quality. A little less tart, juice shows a slight trace of pink.
3	8/16	26.8	.89	7.0	13.4	Fruit greenish with trace of pink. Flesh a little better in texture. A little better in quality. A little less tart. Juice shows noticeable pink color.
4	8/19	27.2	.87	6.5	16.3	Fruit greenish with pronounced trace of color. Flesh of good texture. Fairly good in quality. Less tart. Juice a shade darker.
5	8/22	28.1	.85	7.2	15.6	Fruit greenish amber in color. Flesh of good texture. Fairly good in quality. Reasonably tart. Juice deep pink in color.
6	8/26	28.0	.81	10.6	17.5	Fruit amber in color. Flesh of good texture. Good in quality. Reasonably tart. Juice a little darker in color.
7	8/31	27.8	.76	13.9	20.0	Fruit deep amber in color. Flesh of good texture. Very good in quality and appearance. Not too tart. Juice brilliant red in color.
8	9/4	28.7	.60	15.6	20.5	Fruit deep amber in color. Flesh of good texture. Very good in quality and appearance. Not too tart. Juice a shade darker in color.
9	9/8	28.6	.59	15.9	27.6	Fruit deep amber in color. Flesh good in texture. Very good in quality and appearance. Not too tart. Juice deep red in color.
10	9/12	28.9	.59	17.2	24.0	Fruit brownish, somewhat dead in color. Flesh of good texture. Quality good but generally less desirable than that of lots 8 and 9. Sweet with very little tartness. Juice dark red, almost obscures the fruit.

TABLE X. EFFECTS OF TIME OF PICKING AND STORAGE ON THE CANNING QUALITY OF ITALIAN PRUNES

Love Orchard (Milton-Freewater) stored at 45° F. and 66° F. Canned when fully ripe in 40 percent sirup.

Lot No.	Date of picking and storing	Date of canning	Sirup cut-out (Balling)	Acid in sirup (malic)	Loss of weight (fruit)	Quality
			%	%	%	
1	7/31	8/20	26.5	.78	13.3	Good purplish-brown color. Fairly tart but of good quality. Juice brilliant red in color.
2	8/3	8/22	26.8	.72	16.2	Good purplish-brown color. Moderately tart but of good quality. Juice reddish purple in color.
3	8/6	8/23	27.0	.73	15.6	Good purplish-brown color. Flesh of good texture. Very good in quality. Juice reddish purple in color.
4	8/9	8/25	27.1	.61	14.0	Good purplish-brown color. Flesh of good texture. Very good in quality. Juice reddish purple in color.
5	8/12	8/27	27.0	.61	17.6	Good purplish-brown color. Flesh of good texture. Very good in quality. Juice reddish purple in color.
6	8/15	8/28	27.2	.62	15.6	Good purplish-brown color. Flesh of good texture. Very good in quality. Juice reddish purple in color.
7	8/18	8/25	28.8	.53	13.2	Good purplish-brown color. Flesh of good texture. Very good in quality. Juice reddish purple in color.

TABLE XI. EFFECTS OF TIME OF PICKING AND STORAGE ON THE CANNING QUALITY OF ITALIAN PRUNES

Oaco Orchard (Monroe) Stored at 66° F. Canned when fully ripe in 40 percent sirup.

Lot No.	Date of picking and storing	Date of canning	Sirup cut-out (Balling)	Acid in sirup (malic)	Loss of weight (fruit)	Quality
			%	%		
1	8/10	9/3	26.0	.81	15.4	Good amber-brown color. Moderately tart, but of good quality. Juice brilliant red in color.
2	8/13	9/1	25.5	.77	17.6	Good amber-brown color. Moderately tart but of good quality. Juice brilliant red in color.
3	8/16	8/31	26.5	.78	17.6	Good amber-brown color. Flesh better in texture. Very good in quality. Juice brilliant red in color.
4	8/19	8/31	26.6	.78	19.6	Good amber-brown color. Flesh of good texture. Very good in quality. Juice brilliant red in color.
5	8/22	8/29	27.2	.64	18.8	Good amber-brown color. Flesh of good texture. Very good in quality. Juice brilliant red in color.
6	8/26	8/29	27.6	.63	17.2	Good amber-brown color. Flesh of good texture. Very good in quality. Juice brilliant red in color.

DISCUSSION OF RESULTS ON CANNING EXPERIMENT

Time of picking affects the quality. Obviously, time of picking affects the quality of canned Italian prunes. This was very evident from the results of these tests. By far the best quality was obtained with the fruit that was fully ripe at the time of picking and canning. This fruit gave a product that had good texture and a decided prune flavor.

Time of picking affects the appearance. Time of picking also affected, in a marked degree, the appearance of the canned product. The

prunes canned when fully ripe yielded a brilliant red sirup and fruit of an attractive amber color. This fruit held up well in the cans. The prunes that were picked prematurely all lacked color after canning. The product from the first two pickings, in fact, was entirely devoid of red color and had the appearance of canned Green Gage plums. The prunes that were overripe at the time of picking produced a sirup very dark in color; in some cases the sirup completely obscured the fruit. The fruit itself was dull brown in color and presented a rather dead appearance upon removal from the sirup.

Sirup cut-out. As shown in Table IX, there was a considerable difference in the cut-out or sirup concentration of Italian prunes picked and canned at various stages of maturity. The fruit picked and canned in 40 percent sirup on August 10, for example, gave a sirup cut-out of 26.0 percent, while that picked and canned on September 12 gave a sirup cut-out of 28.9 percent. The prunes of the later pickings, in other words, gave a higher sirup concentration after canning than did the ones picked and canned early in the season. This was to be expected since the fruit of the late pickings showed a higher content of sugar and other soluble solids.

Fruit cut-outs are lower in the case of the riper fruit. Contrary to expectations, the fruit from the later pickings showed a greater loss of weight during the canning operations than did the fruit from the early pickings. In the case of the fruit from the first picking, for example, the loss of weight by the fruit itself was only 6.7 percent, while in the case of the last picking the loss of weight was 17.2 percent.

Just why the riper fruit should show a lower fruit cut-out than that canned earlier in the season is not clear at this time. Studies with sweet cherries and other fruits[5] have generally shown the opposite condition to be true; i. e., the riper the fruit at the time of canning, the higher the fruit cut-out in the canned product.

Shrinkage. Here again the results proved to be the opposite from what was expected. Shrinkage or loss of volume in canned goods is usually the greatest in the case of the immature product, but in these tests the prunes picked and canned on August 10 showed a shrinkage of 12.9 percent, while those picked and canned on September 12 showed a shrinkage of 24.0 percent. The greater size of the fruit from the later pickings, however, more than overcame this disadvantage.

Shrinkage in each case was determined by measuring the volume of the fruit before and after canning. This was accomplished by immersing the fruit in water and computing the amount of displacement.

The canning quality of prunes picked prematurely and ripened in storage. The canning quality of Italian prunes picked prematurely and ripened in storage is of considerable interest to the shippers of fresh prunes and to the consumers who buy these prunes for canning purposes. If fresh Italian prunes are to reach the eastern markets at all, it is evident that they must be harvested comparatively green and must complete their ripening processes in storage or in transit.

Some very interesting data (tables X and XI) were obtained in this phase of the canning experiment. These prunes, in general, gave a product of first class quality, provided they had been picked within the

desirable picking range for fresh fruit shipment, and provided they were allowed to become fully ripe before canning. The product was usually mild in taste and retained much of the flavor characteristic of the variety. As already mentioned, Italian prunes take on color in storage, and it was found that color so acquired holds during the canning process. These prunes, in fact, gave a product that was fully as well colored as that obtained from tree-ripened fruit.

SUMMARY

(1) That time of picking affects materially the dessert quality of Italian prunes was clearly shown by the results of these tests. When picked prematurely the fruit never attained the flavor characteristic of the variety. When picked too late, it soon lost its spiciness and became flat in taste.

(2) Time of picking also affects the keeping quality or storage life of the fruit. Prunes harvested on August 10 required 24 days to reach full maturity at 66° F., while those from the same orchard harvested on August 26 required only three days to become fully ripe at this temperature.

(3) If dessert quality and other factors are to be taken into account, keeping quality must be sacrificed to a certain extent. It appears from these data, however, that if picking is done at the right time, the fruit will not only develop fairly good dessert quality, but will retain sufficient shipping quality to afford ample time for distribution and consumption.

(4) Italian prunes undergo a rather significant increase in weight and volume during the harvesting season. From the beginning of the fresh fruit shipping period to the time when the fruit was fully ripe on the trees, the prunes in the Oaco orchard showed an increase in weight of 24.1 percent and an increase in volume of 22.0 percent.

(5) The acidity of Italian prunes undergoes a gradual and consistent reduction, not only while the fruit is attached to the tree but also while it is in storage.

(6) There is apparently a close correlation between acidity and the dessert quality of these prunes. When ripened in storage they are generally at their best when the acid content is between 1.0 and 0.5 percent.

(7) Italian prunes attached to the tree show an increase in sugar during the ripening period. In the present experiments, the juice of the fruit showed an increase in sugar and other soluble solids from 12.6 to 18.9 percent between August 10 and August 31.

(8) Prunes held in storage show no increase but rather a slight decrease of sugar and other soluble solids. Obviously, the major changes in quality after picking are due to loss of acidity and astringency and not to increases in the amounts of sugar.

(9) The fruit on the trees showed an increase in solid content from 13.3 to 15.3 percent between August 10 and August 22. That held in storage underwent no material change in solid content.

(10) The sugar and acid tests of maturity apparently are not applicable to the Italian prune.

(11) The pressure test is the only guide of maturity which gives promise at this time.

(12) Italian prunes show a consistent and pronounced decrease in resistance to pressure during the ripening period. Storage and ripening tests have shown this decrease to be closely associated with maturity.

(13) From the work of the past two seasons it appears that prunes for eastern shipment should be harvested when the pressure tester registers between 15 and 12 pounds. Additional work must be done, however, before final recommendation can be made concerning picking pressures.

(14) Italian prune orchards in the same locality do not always reach the proper picking stage at the same time.

(15) Fungous diseases such as brown rot, gray mold, and blue mold are the chief causes of decay in Italian prunes after harvest. Mold is usually quite severe on prunes that have been picked with torn stems and that have been bruised in handling operations.

(16) Unlike many other fruits, Italian prunes take on color after picking. In the present experiments, fruits that were almost devoid of color at picking time developed full color during the storage period.

(17) Time of picking affects the quality of canned Italian prunes. By far the best quality was obtained with the fruit that was fully ripe at the time of picking and canning.

(18) Time of picking also affected, in a marked degree, the appearance of the canned product. When the fruit was picked too soon the product was light in color. When the fruit was past its prime, it gave a product that was very dark in color and not altogether attractive.

(19) Prunes of the later pickings gave a higher cut-out or sirup concentration after canning than did the ones that were picked and canned early in the season.

(20) Contrary to expectations, the fruit from the later pickings showed the greatest loss of weight and volume during the canning operations.

(21) The prunes picked early and allowed to ripen in storage gave a product of first class quality, provided they had been picked within the desirable picking range for fresh fruit shipment, and provided they were allowed to become fully ripe before canning.

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